

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:
  - a semiconductor substrate;
  - an active element structure formed on the
  - 5 semiconductor substrate;
  - a first insulating film provided above the semiconductor substrate;
  - a first interconnect layer provided in a surface of the first insulating film and composed of copper;
  - 10 a second insulating film provided on the first insulating film;
  - a connection hole formed in the second insulating film and having a bottom connected to the first interconnect layer;
  - 15 a connection plug composed of a single crystal of copper filling the connection hole so that no other crystals of copper are provided in the connection hole;
  - an interconnect trench formed in a surface of the second insulating film and having a bottom connected to
  - 20 the connection hole; and
  - a second interconnect layer provided in the interconnect trench.
2. The device according to claim 1, further comprising a diffusion preventing metal film extending
- 25 from a bottom of the connection hole to a side wall of the connection hole and an inner surface of the interconnect trench and composed of a material selected

from a group consisting of Ti, W, Ta, Nb, Al, V, Zr, Ni, and their nitrides and oxides, the diffusion preventing film having a thickness of 0.1 to 1 nm.

3. The device according to claim 1, further  
5 comprising a diffusion preventing metal film provided on a inner surface of the connection hole and having an opening reaching the first interconnect layer at the bottom of the connection hole, the diffusion preventing metal film being composed of a material different from  
10 copper.

4. The device according to claim 3, wherein the diffusion preventing metal film is composed of a material selected from a group consisting of Ti, W, Ta, Nb, Al, V, Zr, Ni, and their nitrides and oxides.

15 5. The device according to claim 1, wherein the copper of the connection plug has the same crystal orientation as that in a part of the first interconnect layer which is located immediately below and close to the connection hole in the first interconnect layer.

20 6. The device according to claim 3, wherein the copper of the connection plug has the same crystal orientation as that in a part of the first interconnect layer which is located immediately below and close to the connection hole in the first interconnect layer.

25 7. A method of manufacturing a semiconductor device comprising:

forming an active element structure on the

semiconductor substrate;

forming a first insulating film above the  
semiconductor substrate;

forming an interconnect layer composed of copper  
5 in a surface of the first insulating film;

forming a second insulating film on the first  
insulating film;

forming a connection hole and an interconnect  
trench in the second insulating film, the connection  
10 hole having a bottom connected to the interconnect  
layer, the interconnect trench having a bottom  
connected to the connection hole;

filling the connection hole with copper formed on  
the interconnect layer by epitaxial growth so as not to  
15 form any other crystals of copper in the connection  
hole; and

filling the interconnect trench with copper.

8. The method according to claim 7, further  
comprising:

20 after forming the connection hole and before  
filling the connection hole,

forming a diffusion preventing metal film covering  
inner surfaces of the connection hole and interconnect  
trench and composed of a material selected from a group  
25 consisting of Ti, W, Ta, Nb, Al, V, Zr, Ni, and their  
nitrides and oxides, the diffusion preventing film  
having a thickness of 0.1 to 1 nm; and

forming a base film composed of copper, on the diffusion preventing metal film.

9. The method according to claim 8, wherein filling the connection hole includes forming the copper by an electroplating method using the base film as  
5 a base.

10. The method according to claim 7, wherein filling the connection hole includes:

forming a base film composed of copper, on the interconnect layer at the bottom of the connection  
10 hole; and

forming the copper by an electroplating method using the base film as a base.

11. The method according to claim 7, wherein  
15 filling the connection hole includes forming the copper by an electroless plating method using the interconnect layer as a base.

12. The method according to claim 7, further comprising:

20 after forming the connection hole and before filling the connection hole,

forming a diffusion preventing metal film covering inner surfaces of the connection hole and interconnect trench and composed of a material different from  
25 copper; and

removing the diffusion preventing metal film from the bottom of the connection hole.

13. The method according to claim 7, wherein  
filling the connection hole includes:

forming a diffusion preventing metal film at the  
bottom of the connection hole, the diffusion preventing  
5 metal film being composed of a material different from  
copper;

forming a base film composed of copper, on the  
diffusion preventing metal film; and

forming the copper by an electroless plating  
10 method using the base film as a base.